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Conference Reports

This issue is devoted to reports on some of the major meetings that took place this year, starting with a short summary of an international congress in Beijing in May, and continuing in depth for more recent meetings. Collaboration underpins the practice of classical biological control. The collaborative spirit is also reflected in tightly-knit regional and global groups and communities of biological control scientists, in accounts of experienced countries sharing experience and knowledge with those new to biological control, and in biological control scientists engaging with stakeholders and the general public to increase understanding. Collaboration is now benefiting further from interactions within the sector. The popularity and success of the two first international interdisciplinary conferences reported here has led to a new series of international conferences dedicated to interdisciplinary themes being established, with the next planned for Switzerland in 2021.

The meetings heard about advances, success stories and new opportunities, but also shortcomings, needs and threats. Constructive engagement with regulatory bodies regarding safety has allowed a continued renaissance of biocontrol agent introductions. Another impediment, access and benefit sharing, is proving another tough nut to crack for an approach that that has traditionally relied on the free multilateral exchange of biocontrol agents. Pro-active collaborative initiatives involving scientists from both source and target countries are giving the best chances of resolution.

Biological control has a critical role in safeguarding the environment and agriculture, particularly in the context of emerging invasive species and climate change. New approaches and techniques are helping to improve biological control practice, safety assurance and chances of success. The sector reacts to new challenges, for example through initiatives for emerging pests, and global action on policy issues. This adaptability and reactivity, drawing on the wisdom of experienced scientists and a dynamic new generation, are important facets in building a strong future for biological control.

Interdisciplinary Biological Control in Beijing

The First International Congress of Biological Control was held in Beijing in May of 2018. The meeting was sponsored jointly by two Chinese organizations (the Chinese Academy of Agricultural Sciences and the China Society of Plant Protection), CABI, and the International Organisation for Biological Control (IOBC). One of the over-arching themes of the congress was multidisciplinarity in biological control. In other words, the congress was not only about biological control of weeds, or of insects, or of plant pathogens, or of vertebrate animals. Nor was it only about biological control using a particular approach – like conservation or augmentation or importation. Rather – it was about all of these and attempted an open-tent approach in which biological control could be seen in its entirety.

As far as I'm aware, this was the first-ever international conference on biological control that was all-encompassing in this way and it achieved the goal of generating excitement about the idea of sub-disciplines of biological control learning from one another. It was also quite large, with over 1000 attendees with representation from over 40 countries and featuring 12 plenary addresses, which were delivered to all attendees. Collectively the plenary addresses covered very broad ground, beginning with an impassioned plea for multi- and interdisciplinarity by Professor Nick Mills from the University of California, Berkeley. Other plenary speakers focused on cutting-edge advances in biological control of insects, plant pathogens and vertebrate pests. Some of the developments in biological control in China were highlighted as well, and it is clear that lots of interesting advances are taking place there in many areas of biological control. Beyond the plenaries, the congress supported 15 sessions, nine of which were designated as 'interdisciplinary' by the scientific committee, which meant that an effort was made to choose a broad theme and then to recruit speakers from diverse areas of biological control to address that theme. The interdisciplinary session themes were as follows: *Risk Assessment and Biosafety in Biological Control*; *Evolution and Genetics in Biological Control*; *Biological Control as a Means of Preserving Biodiversity*; *Biological Control as an Ecosystem Service*; *Biological Control in Support of Human Health*; *Biological Control and Climate Change*; *Natural Enemy Action: Mechanisms and Interactions*; *Socio-economic Impacts of Biological Control*; and *Biological Control in IPM Systems*.

I don't think there is any doubt among the attendees that this approach to a meeting has value and there was a lot of enthusiasm about the future congresses of this type. In fact, plans are already underway for the Second International Congress of Biological Control in 2021 in Switzerland. The planning efforts will be housed within the IOBC and a committee is being formed that will oversee the organization.

By: George Heimpel, President, IOBC-Global.

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Web: www.iobc-global.org/publications.html

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First International Conference on Biological Control: Approaches and Applications

The First International Conference on Biological Control: Approaches and Applications was held on 27–29 September 2018 in Bengaluru, India. The conference was organized by the Society for Biocontrol Advancement (SBA) and the Indian Council of Agricultural Research – National Bureau of Agricultural Insect Resources (ICAR–NBAIR) in collaboration with CABI, the International Association for the Plant Protection Sciences (IAPPS *Tuta absoluta* Working Group workshop) and the International Organisation for Biological Control (Third International Workshop of the IOBC Global Working Group on Parthenium Weed). The Organizing Committee comprised Chandish R. Ballal (President), Sushil K. Jalali (Chief Organizing Secretary) and G. Sivakumar (Secretary). The conference was attended by 246 delegates including 43 from 20 countries outside India. One hundred and eighteen talks and 103 posters in nine sessions were presented. The two workshops are reported separately below.

T. Mohapatra (Secretary, Department of Agricultural Research & Education and Director General, ICAR, New Delhi), David Smith (Director Biological Resources, CABI, UK) and R. Muniappan (Director, Virginia Tech, USA) inaugurated the conference.

The opening keynote lecture was presented by Quirico Migheli, the Editor-in-Chief of the journal *Biocontrol Science and Technology*, who talked about his perspective on why so many manuscripts are rejected for publication and emphasized his concern that scientific effort and public funds are wasted if the research is not published. He reported that about 60% of submitted manuscripts are rejected, mainly on the grounds that they are: inappropriate for the journal; poorly written; the rationale is unclear; they lack novelty. Poor experimental design and replication are other reasons for rejection. He particularly expressed concern at the increasing incidences of plagiarism, and noted that this is grounds for instant rejection of a manuscript.

The Session on *Biodiversity, Biosecurity and Conservation Strategies* included three 'lead talks'. Firstly N. K. Krishna Kumar (Bioversity International, New Delhi) presented an ecological perspective on insect pest management, emphasizing the importance of maintaining and enhancing biodiversity in agro-ecosystems. V. V. Ramamurthy (ICAR, New Delhi) talked about the importance of both morphological and molecular taxonomy in understanding biodiversity in cropping systems, and for biological control. He expressed concern that taxonomy is a discipline in decline, and encouraged young researchers to ensure that taxonomy is incorporated into biological control research programmes. Abraham Verghese (GPS Institute of Agricultural Management, Bengaluru) addressed the issue of conservation of natural enemies in farmland, but pointed out that 63% of farmers in India farm on less than 1 ha, and only about 20% of farmers have more than 10 ha. The small-scale farmers find it challenging to leave areas of land for natural enemy conservation, whereas this is more achievable for farmers with more land. There were 12 further papers in this session, many of which gave examples of the large diversity of natural enemies available in agricultural ecosystems and their conservation.

A session on *Production and Utilization of Microbials for Insect Pest and Disease Management* was opened by David Smith (CABI, UK), who talked about the Nagoya Protocol for Access and Benefit Sharing (ABS) and the impact that this is already starting to have on the practice of biological control. He talked about the legislation that was being introduced in many countries and the difficulties that are being experienced in working through the mechanisms for obtaining permits to collect biocontrol agents in some countries. This issue was also addressed by Barbara Barratt (AgResearch, New Zealand), who outlined the IOBC response to ABS, and the activities of the Global Commission of IOBC, making the case that biological control should not be treated in the same way as profit making use of genetic resources. IOBC has developed a best practice guideline document which seeks to guide biological control practitioners in complying with ABS.

Another lead talk in the Microbials session was presented by A. N. Mukhopadhyay (formerly Assam Agricultural University) who is known as the 'father of *Trichoderma*'. His presentation on *Trichoderma* was subtitled 'a gift of God to mankind'. He gave an inspiring talk on the history of *Trichoderma* development as a microbial agent for use in India, the methods of mass production that have been developed, seed treatment technology and how this has reduced costs by reducing quantities required to control plant pathogens.

The lead talk in the session on *Biological Control of Invasive Pests and Weeds* was presented by Djami Djeddour (CABI, UK) who gave a historical perspective on classical biological control of weeds, and future prospects. She pointed out that invasive species incur a global economic cost of US$ 1.4 trillion per year. She also pointed out that weed biological control has been very successfully used in many countries, but that the potential has not been realized unilaterally. The UK, for example, has only recently introduced biocontrol agents starting in 2010, and four agents have now been released. Japanese knotweed (*Fallopia japonica*) was the first target in the UK, for which a Japanese psyllid (*Aphalara itadori*) has been released, but it has established quite slowly and this required management of public expectations. Other presentations in that session covered a range of pests including aphids, spiralling whitefly (*Aleurodicus dispersus*) and mealybugs.

A session on *Biological Control: Industrial Perspectives and Policy Issues* included wide-ranging talks from Taiwan (using existing natural enemies), Costa Rica (mass production methods for fruit fly parasitoids), Nepal (biopesticides for pest management) and India (registration and commercialization of biopesticides).

Richard Stouthamer (University of California, Riverside) opened the session on *Production and*

Utilization of Macrobials for Insect Pest Management, talking about optimizing the genetics of biocontrol agents for classical and augmentative applications. He pointed out that the success rate of biological control, currently only about 10%, could be much improved if methods for improving genetic diversity of the agents released in the field were employed. This included rearing large numbers of separate isofemale lines individually to avoid selection and 'domestication' of laboratory strains. The isofemale lines should then be mated before release thereby maintaining maximum genetic diversity.

Chandish R. Ballal (ICAR-NBAIR, Bengaluru) posed the question as to whether macrobial biocontrol agents might be losing out to microbials. She noted that in India microbials can be produced and stored easily so that they lend themselves to commercial development. Macrobials, however, have been hardly commercialized at all, and there are challenges in setting up facilities for rearing. However, they have the advantage that they do not need to be registered. She encouraged students to find and study naturally occurring natural enemies, and made a case for the establishment of small regional biocontrol agent rearing facilities.

R. Muniappan (Virginia Tech) ran the workshop of the IAPPS Working Group on *Tuta absoluta*. The opening address was presented by Abhijin Adiga (Virginia Tech) who talked about multipathway models to understand weed spread. These hybrid models incorporate biological and climatic as well as anthropogenic (e.g. trade, economics) drivers of the spread of invasive species.

A session on *Biotechnological Approaches in Biological Control* included presentations on *Bt* and other novel insecticidal proteins, and integration of pest management technologies was considered in a further session, *Biological Control Compatible Approaches*, where the compatibility between pesticides and biocontrol agents was discussed. Biointensive pest management (BIPM) for rice production was discussed as part of the 'go green initiative'. The emphasis here is on manipulating the habitat in such a way that pests are disadvantaged, but natural enemies benefit.

A. N. Mukhopadhyay was the chief guest for the Valedictory Function on the final day. It was announced that the proceedings of the conference will be published in *Biocontrol Science and Technology*. 'Best Oral Presentation' and 'Best Poster Presentation' awards were also given away during this session. There was a discussion of the next venue, and it was agreed that much was to be gained by combining this conference with the International Congress of Biological Control which was also held for the first time this year in May in Beijing (see previous report). Since the aims of the two conferences were similar, i.e. to cover all aspects of biological control in a single conference and within sessions, and that the venue for the next congress had been more or less finalized (Switzerland, 2021), it was agreed that combining these meetings was the best way forward. Members of both organizing committees would contribute their combined experiences to the benefit of the next international conference on biological control.

By: Barbara I. P. Barratt, AgResearch Ltd, New Zealand.

IOBC Working Group Workshop on Parthenium Weed

Parthenium hysterophorus (parthenium weed) is one of the most severe terrestrial invasive alien plants, invading at least 48 countries in Africa, Asia and Australia. Invasions can significantly reduce crop yield, reduce palatable grazing for livestock and wildlife (with economic impacts), and may exclude native vegetation. Repeated exposure causes severe allergic symptoms (hayfever, dermatitis) in humans and animals.

Australia has utilized two pathogens and nine insect agents to measurably reduce density and spread of parthenium weed. Other countries are at various stages of biological control utilization. South Africa has introduced a rust fungus and three insect species, Ethiopia and Uganda have introduced two insect agents, while one was released several decades ago in India and more recently in Tanzania. The winter rust fungus is present in many countries, although not deliberately introduced to most. It is known that a suite of natural enemies affecting multiple plant parts is required to reduce parthenium weed to manageable levels.

A Global Working Group on Parthenium Weed was established in 2009, under the auspices of the International Organisation for Biological Control (IOBC), building on the International Parthenium Weed Network coordinated by the University of Queensland, Australia which hosts a discussion platform and produces a bi-annual newsletter.

Subsequent to earlier workshops held in Kenya in 2010 and Ethiopia in 2014, the Third International Workshop of the IOBC Global Working Group on Biological Control and Management of Parthenium Weed was held on 27–29 September 2018 in Bengaluru, India, in conjunction with the First International Conference on Biological Control (ICBC): Approaches and Applications (see report above). The workshop brought together international researchers working on parthenium weed to disseminate information on the weed and its management, increase collaboration regionally and globally, and optimize resources for control and technology transfer. Some 23 representatives from ten countries (India, Australia, USA, South Africa, Ethiopia, Uganda, Switzerland [for Pakistan], China, Nepal and Bangladesh) participated. Seventeen papers were presented under three themes: *Spread and Impact of Parthenium hysterophorus; Evaluation of Biological Control*; and *New Initiatives*, and discussions ensued, benefitting all participants.

The keynote address discussed parthenium biological control achievements in Australia, which have formed the foundation for other countries. Recent or new biological control initiatives in India, Uganda

and Pakistan were encouraging as biological control begins to be more widely utilized. Representatives for Pakistan, Nepal and Bangladesh, which have not yet intentionally introduced biocontrol agents for parthenium weed, were interested to initiate programmes. The situation in Bangladesh indicated the dire need for intervention: the weed has expanded exponentially within a decade from 8 to 45 districts invaded of a total 64.

Research by the University of Queensland indicated that elevated CO_2 levels altered the morphology and dormancy of parthenium weed seed, with implications for invasion. Presentations on *Zygogramma bicolorata* in India, Ethiopia and Nepal discussed the impact of altitude, leaf consumption, host range, and predictions for its potential distribution. The combined impact of rust fungus and insect agents significantly reduced parthenium cover in a South African study. Presentations on ethanolic extracts of other plants and mycoherbicides demonstrated that parthenium seed germination and growth can be impeded quickly by these methods.

The workshop concluded by developing a set of recommendations arising from the presentations and discussions. Among others, the main recommendations were: (i) All countries where parthenium weed is present are urged to take action to intervene in its spread and impact, as the current situation will worsen without broader, urgent management interventions; (ii) Progress made with regional projects such as the IPM Innovation Lab project in East Africa was recognized, and continued efforts and introduction of additional agents were recommended; (iii) Countries and regional projects are encouraged to quantify the spread and economic, social and health impacts of the weed and its introduced agents; (iv) All countries should follow the International Standards for Phytosanitary Measures No. 3 (*Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms*); (v) Countries that have introduced only one or two biocontrol agents are urged to introduce others as a suite of natural enemies is required to achieve desirable levels of control. Damaging agents besides *Z. bicolorata* are known and available. Some agents may be more suitable for certain conditions than others so area-specific selection should be considered; (vi) Regional and international collaborative programmes are encouraged for cost-effective technology transfer, and donor agencies are urged to support them; (vii) Countries without biological control programmes are encouraged to initiate programmes; (viii) Technical support including capacity building and training should be provided to interested countries to develop biological control and other management options; (ix) As disturbance and lack of competitive vegetation facilitate invasion by parthenium weed, the development of improved land management practices is encouraged.

Future actions of the Working Group were discussed. The next workshop of the IOBC Working Group on Parthenium Weed will be held in about three years, with Nepal or South Africa suggested as potential venues. Information on parthenium weed and its management, will be developed for the Working Group website.

Field visits are always beneficial. To this end, a field visit on the morning of 29 September concluded the workshop. A roadside infestation of parthenium weed within the Bengaluru urban area had workshop participants keenly searching for signs of *Z. bicolorata*. Although some adult beetles, eggs and characteristic feeding damage were observed, some participants were disappointed not to view more extensive defoliation, given the time since introduction of the beetle into India (although this is not the situation in all areas). However, together with the dense infestations observed in many locations, this reality highlighted the need for a suite of natural enemies for wider control, and additional control methods incorporated in an integrated management approach.

As part of ICBC, two presenters from this workshop received 'Best Paper Awards' on the final day during the ICBC Valedictory Function.

Finally, we acknowledge the support received from IOBC and the USAID-funded IPM Innovation Lab at Virginia Tech, USA, for this workshop.

For further information contact:
StrathieL@arc.agric.za

By: Lorraine Strathie[1] and
Prakya Sreerama Kumar[2]

[1] Agricultural Research Council – Plant Health and Protection, Hilton, South Africa.

[2] Indian Council of Agricultural Research – National Bureau of Agricultural Insect Resources, Bengaluru, India.

Workshop of the IAPPS Working Group on *Tuta absoluta*

The gelechiid moth *Tuta absoluta* is an invasive pest of great significance in Europe, Africa and Asia. The IPM Innovation Lab at Virginia Tech (USA) initiated awareness initiatives in Africa after *T. absoluta* invaded Senegal in 2012, and subsequently in Asia after the pest reached that continent in 2014. Since then, *T. absoluta* symposia during regional and international meetings have facilitated exchange of information and cooperation. A *Tuta absoluta* Working Group was formed in October 2015, under the auspices of the International Association for the Plant Protection Sciences (IAPPS).

The Workshop of the IAPPS Working Group on *Tuta absoluta* – Biology, Ecology and Management took place in Bengaluru, India, on 28 September 2018, alongside the First International Conference on Biological Control: Approaches and Applications (see report above). There were 11 presentations, including a keynote, and 50 participants represented five countries.

In the keynote talk, 'Multi-pathway models to understand the spread and impact of *Tuta absoluta*', Abhijin Adiga (Virginia Tech) explained how, through the use of network science and computational epidemiology, robust hybrid models have been developed to study the role of natural and anthropogenic drivers of invasive species spread, with application to *T. absoluta.* The talk focused on how this new modelling approach is useful to analyse the spread of the pest, and takes into consideration the role of the tomato trade, the effect of climate change and economic impact.

The first presentation gave an overview on the role of the IPM Innovation Lab in the management of *T. absoluta* around the globe. Topics such as biology, host range, thermal requirements for pest development, population build-up and genetic diversity of the pest were addressed by Indian scientists. The various biological control options available as well as integrated pest management (IPM) modules were also discussed, along with the potential use of sterile insect technique (SIT). Use of a nanomatrix for controlled release of *T. absoluta* female sex pheromone was yet another study from India. The only presenter from Nepal discussed the various management options available in his country. A Bangladeshi presentation dealt with risk assessment and management of *T. absoluta.* Each talk was followed by a lively discussion.

The workshop ended by developing a set of recommendations:

- Classical, augmentative and conservation biological control to be encouraged.
- Modelling of *Tuta* around the world to be continued.
- Pesticide resistance management to be emphasized, including rotation of insecticides with different modes of action.
- Donor agencies to be encouraged to support *Tuta* management research and outreach.
- Support to be given for host plant resistance research using a collaborative mode.
- Emphasis to be placed on area-wide management through use of pheromones, SIT/IPM, etc.
- Information on *Tuta* management to be produced in local languages and disseminated.
- Information on *Tuta* on the IPM Innovation Lab website and CABI portal to be consolidated.

The Indian paper on nanomatrix and the presentation from Nepal each won a 'Best Oral Presentation Award'.

By: Rangaswamy Muniappan[1] and
Prakya Sreerama Kumar[2]

[1] IPM Innovation Lab, Virginia Tech,
Blacksburg, Virginia.

[2] Indian Council of Agricultural Research –
National Bureau of Agricultural Insect Resources,
Bengaluru, India.

Back to its Roots: ISBCW XV in Engelberg, Switzerland

The XV International Symposium on Biological Control of Weeds (ISBCW) took place from 26–31 August 2018 in the picturesque Swiss Alpine village of Engelberg. The first ISBCW was organized in 1969 by CABI Switzerland (back then the European Station of the Commonwealth Institute of Biological Control) in Delémont, Switzerland. Almost 50 years later, ISBCW came back to its roots, and in that time it has grown from 20 scientists representing 15 institutes and organizations in eight countries to 203 scientists representing over 100 institutes in 25 countries. The countries most represented were USA with 55 delegates, followed by South Africa with 30, Australia with 21, China and Switzerland with 19 and New Zealand with 13.

The XV ISBCW aimed to bring together practitioners, scientists and regulators working in the field of weed biological control to share their experiences, network, foster collaborations, and discuss emerging issues that affect management of invasive plants with natural enemies. Special emphasis was placed on presenting and discussing new methods to determine the efficacy, environmental safety and predictability of biological control, including the role of chemical ecology, modelling and the '–omics' field, with the general aim to advance the science and success of weed biological control. Each session of the symposium was introduced by a keynote speech from a prominent scientist who has contributed significantly in their field. The programme was carefully developed to allow a logical progression while setting the stage for the next theme. A total of ten keynotes, 81 oral presentations and 105 posters were presented during the symposium. In addition, there were five workshops that ran over three of the evenings, as well as a panel discussion on *Alien Invasive Plants: Do We Need to Control Them and If Yes, How?*, highlighting the importance and potential of weed biological control in Europe.

The symposium touched on diverse aspects in the ten sessions:

1. *Target and Agent Selection* – Louise Morin (CSIRO, Australia) kicked off the symposium with a keynote about the Australian experience with their relatively recent prioritization tool to support target selection for biological control. She stressed the importance of making transparent decisions that can be adapted as new information becomes available. Louise also touched on predicting the efficacy of agents after release in a new region and highlighted that this still remains a major challenge.

2. *Opportunities and Constraints for Classical Weed Biocontrol in Developing Countries* – Rangaswamy Muniappan (Muni) (Virginia Tech, USA) introduced the session by using well-known examples to highlight both opportunities and constraints in developing countries, particularly in Africa and Asia. He stressed that biological control offers sustainable options for mitigating the negative impacts of invasive weeds.

3. *Bioherbicides* – This session got underway with a keynote by Karen Bailey (formerly Agriculture and Agri-Food Canada [AAFC]), who clarified the hurdles in developing a biopesticide for widespread use. She also encouraged scientists to better integrate the science behind developing a biopesticide with commercial needs.

4. *Novel Methods to Determine Efficacy and Environmental Safety of Agents* – Greg Wheeler (US Department of Agriculture –Agricultural Research Service [USDA-ARS]) introduced this session by using the overlap of chemical ecology and biological control of weeds to highlight the many opportunities to exploit potentially coevolved relationships between agents and their host plants.

5. *Making Classical Biological Control More Predictable: Moving from Ecological to Evolutionary Processes* – Heinz Müller-Schärer (University of Fribourg, Switzerland) used the recent invasion of common ragweed (*Ambrosia artemisiifolia*) and the unintentional introduction of the ragweed beetle (*Ophraella communa*) into Europe to highlight ongoing research from ecological to evolutionary perspectives to better predict benefits and risks in weed biological control.

6. *Regulations for Agent Release and Access to Genetic Resources* – This topic has become increasingly important in weed biological control. Peter Mason (AAFC) introduced the session by suggesting that unintended effects of the Anthropocene included concerns for the preservation of biodiversity and the equitable sharing of its benefits. As a result, this brings tighter regulations for accessing genetic resources and releasing biocontrol agents.

7. *Social and Economic Assessments of Biological Control* – Brian Van Wilgen (Stellenbosch University, South Africa) highlighted some examples where the returns on investment from biological control range from 3.5:1 to >3000:1. He also drew attention to a recent ten-year study from South Africa which showed that, on average, unchecked individual alien plant species increased in range by 50%, and ongoing mechanical and chemical control had no detectable effect. Biological control, on the other hand, significantly slowed or reversed the spread of 33 alien plant species.

8. *Opportunities and Constraints for Classical Weed Biocontrol in Developed Countries* – Elizabete Marchante (University of Coimbra, Portugal) delivered a fascinating account of the biological control programme against *Acacia longifolia* in Portugal, where for the first time a weed biocontrol agent was deliberately released in continental Europe. She also drew attention to some of the constraints that new introductions face, for instance in terms of regulations and bureaucracy, but also scepticism of stakeholders and citizens in general.

9. *Post-release Monitoring and Evaluation* – Quentin Paynter (Landcare Research, New Zealand) was well placed to give the keynote for this session, given New Zealand's systematic and novel approaches in this subject. Quentin described approaches to prioritizing agents that are less likely to be negatively impacted by biotic interferences, and also the development of a quantitative approach to interpreting host-specificity testing results, which allowed regulators to authorize the release of agents that would previously have been rejected.

10. *Integrated Weed Management and Restoration* – Tom Dudley (University of California, Santa Barbara) used the contentious biological control programme against *Tamarix* spp. to highlight the importance of restoration in combination with biological control to mitigate any indirect non-target effects resulting from the programme. If successful, this may allow re-initiation of the *Tamarix* biological control programme coupled with habitat enhancement for wildlife species of conservation concern.

Poster awards

Symposium participants had a chance to vote for the two best posters in each of the two poster sessions, which was widely taken advantage of. Prizes were given out on the last day and consisted of CABI books on the Invasives theme. The winners were Blair Cowie (University of the Witwatersrand, South Africa), Nagalingam Kumaran (CSIRO, Australia), Julie Coetzee (Centre for Biological Control, Rhodes University, South Africa) and Iris Stiers (Vrije Universiteit Brussel, Belgium).

Workshops

Biological Control of Grasses – organized by: John Goolsby (USDA-ARS, Edinburg, Texas), Iain Paterson (Centre for Biological Control, Rhodes University, South Africa) and Massimo Cristofaro (Biotechnology and Biological Control Agency [BBCA], Italy)

Grasses are traditionally considered poor targets for classical biological control but recent successes, particularly with *Arundo donax* in southern Texas, USA, suggest that this view should be changed. After discussing the challenges and opportunities for grass biological control, participants generally agreed that the prospects for controlling a number of very damaging invasive alien grasses are good. There are a number of new projects against grass targets, and although these projects are in the early stages, some promising natural enemies have been discovered. Many of the natural enemies of grasses have also been found to be highly host specific, even at the intraspecific level, so including genetic analyses of both the target plants and agents is likely to be important. If realistic goals are set, many invasive grass species could be successfully controlled using biological control. In the end, it was concluded that grass targets present similar challenges as any other targets and should be treated similarly.

Arts and Science of Native Range Explorations – organized by: Kunjithapatham Dhileepan (Biosecurity Queensland, Brisbane, Australia) and Matt Purcell (USDA-ARS, Australian Biological Control Laboratory, CSIRO Health and Biosecurity, Brisbane)

Discussions among the participants of this workshop touched on: (1) The Nagoya Protocol and the utilization of material transfer agreements (MTAs) for the shipping/import of potential biocontrol agents (with reference to the USA and CABI). Regulations vary widely between countries and no consensus was reached on how the Protocol would account for moving biocontrol agents from one country to another when they were originally accessed from a third country (in the native range). (2) The creation of databases, both for points of contact in different countries/regions as well as for taxonomists, to facilitate the identification of collected potential agents (possibly the International Organisation for Biological Control [IOBC] could host and maintain such a database). (3) Genetic techniques, which are becoming more important in biological surveys, but need to be considered in combination with behavioural and population genetic assessments to reduce the chances of overlooking cryptic species.

Implications of Weed Biotypic Variation for Biocontrol Programmes using Fungal Pathogens – organized by: Kate Pollard, Marion Seier and Carol Ellison (CABI, UK)

This workshop stimulated a lively discussion around the susceptibility of different UK Himalayan balsam (*Impatiens glandulifera*) biotypes to the biocontrol agent *Puccinia komarovii* var. *glanduliferae,* as well as the variability of invasive *Rubus* spp. in Australia. Ideas discussed included pooling different biotypes of the biocontrol agent as mixed inoculum in order to select the most virulent from inoculated plants, and using 'trap gardens' in the native range planted with biotypes of the target weed from the introduced range. The need to conduct thorough molecular studies to better understand invasion histories prior to surveys was highlighted, as well as how specificity issues linked to the biotypic variation of target weeds are by no means restricted to fungal pathogens as biocontrol agents, but also need to be considered for insects and mites.

Taking Biological Control to Our Communities – organized by: Kim Weaver and Philip Ivey (Centre for Biological Control, Rhodes University, South Africa)

The 29 participants of this workshop were all enthusiastic about sharing what they do in their respective organizations and countries with regards to public engagement. Working in groups, ways were designed to engage with different communities and some interesting ideas emerged. The organizers will be putting the results together and collaborating with those that show interest to prepare a paper on ways in which to take biological control to our communities.

The Nagoya Protocol and its Implications for Classical Weed Biological Control – organized by: Alejandro Sosa (Fundación Para el Estudio de Especies Invasivas [FuEDEI] and CONICET [Consejo Nacional de Investigaciones Científicas y Técnicas], Buenos Aires, Argentina), Fernando McKay (FuEDEI), Luciana Silvestri (Instituto de Ciencias Humanas, Sociales y Ambientales [INCIHUSA]-CONICET, Mendoza, Argentina), Stephen Hight (USDA-ARS, Tallahassee, Florida), Martin Hill (Rhodes University, South Africa) and Marcelo Vitorino (Fundação Universidade Regional de Blumenau [FURB], Brazil)

The Nagoya Protocol has significant implications for classical weed biological control and each country has interpreted the Protocol differently. Thus the workshop invited participants to share ideas on how to work within the regulations. Luciana Silvestri delivered a paper on the situation in Argentina, outlining that both the national and provincial governments are still grappling with the legislation and there is no consensus to date. Fernando McKay presented on a recent case where FuEDEI had been able to get permission from the Provincial Government of Buenos Aires to export a potential biocontrol agent to the USA, illustrating that exports need to be tackled on a case by case basis. Although the Protocol entered into force in Argentina in March 2017, its practical implementation and development of unified criteria among the Provinces is only expected by the end of 2019. Marcelo Vitorino explained that while Brazil has not yet signed the Protocol, its adoption is imminent since an online system regarding access and benefit sharing (ABS) has already been implemented. The take-home message from the workshop was that there was no 'quick fix' and that individual countries are still debating how ABS agreements apply to non-commercial uses.

Panel discussion

Although biological control of weeds has been practised for over 100 years, it is still a neglected tool in managing invasive alien weeds in Europe. Taking advantage of the fact that the symposium took place in Switzerland, a panel discussion was organized, inviting five participants with different backgrounds and viewpoints on the subject: Nicola Schönenberger (consultant at INNOVABRIDGE Foundation, Switzerland); Elizabete Marchante (University of Coimbra, Centre for Functional Ecology, Portugal); Christoph Küffer (ETH Zürich, Department of Environmental Systems Science, Switzerland); Heinz Müller Schärer (University of Fribourg, Department of Biology, Switzerland); and Richard Shaw (CABI, UK).

Sarah Pearson Perret from Pro Natura led the discussion, starting by asking the panel members about their perspectives on the current situation regarding invasive plants in their respective countries, the challenges that they perceive and why they have not given up yet. Finally, she asked: since biological control of weeds is so successful, why is the method not readily taken up in Europe? Some of the take-home messages from the discussion were:

- Invasive plants can be a big problem in Europe.
- Invasive plants are only one factor threatening biodiversity.
- Communication and education are vital, but it is a two-way process, not just a question of scientists disseminating expert information. We need to listen and take interests and values of the relevant stakeholders seriously. Values are subjective and often

more important to people than objective information.

• To increase visibility and buy-in at the right level, a 'champion' biological control target is needed that everybody agrees should be controlled; and a success story is desperately needed.

• Biological control is an opportunity because it does not aim to eradicate the target plant, but find a new equilibrium. However, biological control needs to be better communicated. At the moment the message 'alien vs alien' is confusing and counterintuitive to the general public.

• Overall, the prospects for biological control of invasive plants in Europe are positive.

International Organisation for Biological Control

George Heimpel, the current President of IOBC, and Barbara Barratt, past-President, were invited to give a presentation about IOBC and the potential advantages of forming a Global Working Group for Classical Biological Control of Weeds under its umbrella. During ISBCW VIII in New Zealand in 1992, participants voted against 'joining' IOBC, but times have changed. A preliminary vote was positive, i.e. either participants voted for the idea or expressed no view. An online survey will follow to allow people who could not attend the symposium to also have their say. It was proposed that the next four years should act as an 'engagement' period until the next ISBCW, when a formal group could be established and any 'marriage' could be announced. During this time Hariet Hinz (with support from Raghu Sathyamurthy and Bernd Blossey) will act as point(s) of contact. The forming of a Global Working Group for Classical Biological Control of Weeds could help in efforts to further raise the profile and awareness of weed biological control and to provide a mechanism to 'lobby' for its increased use.

Winston et al. 2014 – Weeds catalogue

Participants were agreed that the weeds catalogue is an important resource for the biological control community and that at the very least the online version (www.ibiocontrol.org/catalog/) should be regularly updated. However, this does come at a cost which will be graciously provided by the University of Idaho – Mark Schwarzländer, CSIRO – Andy Sheppard, the Centre for Biological Control, South Africa – Martin Hill, Landcare Research, New Zealand – Lynley Hayes, and Canada through CABI – Hariet Hinz. A further US$ 4000 is being sought by Mark Schwarzländer at the moment. Contributors are welcome!

Venue of next ISBCW

Two groups, one from Landcare Research, New Zealand, and one from Argentina and Brazil presented themselves as potential future hosts. Both presentations gave eye-opening and mouth-watering flavours of the respective venues but after a vote the clear winner was Argentina/Brazil. The XVI ISBCW will therefore take place in Puerto Iguazú, Misiones Province, Argentina, in May 2020, and will be co-organized by FuEDEI in Argentina, and by FURB and the Universidad Federal do Viçosa in Brazil.

Conclusions

Judging by the diverse participation in terms of gender, nationality and age, weed biological control is not only a growing discipline but appears to be attractive to driven young scientists, with high aspirations. Numerous presentations highlighted the constant search for new, innovative methods to advance the discipline, be it scientifically or through greater outreach. The increasing bureaucracy around the regulations for ABS has put pressure on weed biological control, although we understand there is no 'quick fix' and as a community we will stand together and face it head on. The overall feeling is that floodgates to weed biological control in Europe are about to burst and that this approach will be considered a valuable asset in the toolkit for the management of invasive weeds.

The XV ISBCW highlighted once more the family nature of the weed biological control community. We can all be proud to be a part of that.

By: Philip Weyl and Hariet Hinz, CABI.

Biological Control of Pests and Diseases: Conference in Pakistan

The International Conference on Biological Control of Pests & Diseases: Progress & Prospects, which was held in Karachi, Pakistan, on 9–11 July 2018, covered wide-ranging themes: biological control of plant pathogens, insect pests, weeds, nematodes and rodents, use of entomopathogenic fungi and nematodes, use of botanicals against pathogens and insect pests, as well as population biology of pests. The conference was attended by over 150 researchers from government and universities around Pakistan and many students.

Across sessions, many options for controlling pests and diseases of vegetable and fruit crops were presented. Botanicals are much-researched in South Asia, and it was interesting to hear about results with this approach. Invasive mealybugs and other hemipterans featured prominently among insect pests, while a presentation by Ehsan ul Haq highlighted commercial and economic aspects of insect pest control. There were, however, only two papers on weed biological control.

Michael Day (Queensland, Australia) represented the International Organisation for Biological Control (IOBC) – others invited under its auspices were unfortunately unable to attend. He highlighted the potential for weed biological control in the keynote address, 'Biological control of weeds: opportunities for Pakistan'. He also explained its low-risk implementation in a presentation on 'Minimizing risks in weed biological control – host specificity testing of biocontrol agents' during a later session. As in many countries, there seems to be acceptance in Pakistan of biological control for insect pests and diseases, but not for weeds. This is an area where organizations such as IOBC can play a role in communicating the specificity, efficacy and low-risk nature of weed biocontrol agents.

By: Michael Day, IOBC.

Biocontrol Comes to Prominence at the XV International Congress of Acarology

Biological control was one of the most prominent subjects presented, discussed and debated both inside and outside the conference halls during the XV International Congress of Acarology, which was held in Antalya in Turkey on 2–8 September 2018. Topics such as the use of predatory mites as biocontrol agents as well as biological control of phytophagous mites are certainly surging, especially in the context of more and more agricultural and horticultural crops being cultivated under protected systems across continents. Incidentally, Antalya boasts of having 83% of Turkey's glass greenhouses, along with 52% of its plastic greenhouses, 12% of high plastic tunnels and 8% of low plastic tunnels (www.hortidaily.com). One can clearly see the hectares and hectares of these structures from the aeroplane window.

There were six keynote presentations during the congress, which was themed *The Acari: Small but Impossible to Deny!* Interestingly, the first two papers, one on 'Mites in a changing world' (by Maria Navajas) and the other on 'The influence of global warming on tick vectors' (by Kosta Y. Mumcuoglu) both warned on the adverse impact of climate change, and the likelihood of it leading to the spread of phytophagous mites as well as ticks to newer regions and previously unfavourable areas. In many respects, though, the keynote paper titled 'Behavioral plasticity of plant-inhabiting predatory mites shaped by early life experiences' (by Peter Schausberger) set the ball rolling as far as biological control through predatory mites was concerned.

The oral presentations on biological control, grouped into five sections, were presented over three days. It was clearly evident from the presentations that predatory phytoseiid mites such as *Phytoseiulus persimilis*, *Amblyseius swirskii* and *Neoseiulus californicus* are valued highly in various countries, as much for their performance as for their commercial availability. It is heartening to note that various other less-known but potentially useful phytoseiids like *Amblyseius tamatavensis*, *Kampimodromus aberrans* and *Typhlodromus athiasae* are also being investigated for biological control of both phytophagous mites and small, sucking insects. There was, nevertheless, a serious lack of work on other predatory families such as Bdellidae, Cunaxidae, and others under the Acariformes.

Banker-Sheet™, a plant-attached shelter that can hold sachets of *N. californicus* or *A. swirskii*, is a new invention that promises increased efficacy of these predatory mites by protecting them and enhancing their release on crops. This new technology is being used in several crops in Japan already, a paper announced.

Displacement of existing predatory mites by exotic ones was one of the topics of interest. In Japan, the imported *N. californicus* (Spical®) could displace the original inhabitant, *N. womersleyi*, especially due to different degrees of pesticide (e.g. acetamiprid and imidacloprid) susceptibility in fruit tree orchards. This phenomenon could possibly happen in other countries as well, where commercially available exotic predatory mites are introduced on the market. Almost similar displacement has also occurred in southern Florida, USA, where *Neoseiulus longispinosus* from Asia is now more dominant than the previously abundant predators, *N. chilenensis* and *Amblyseius largoensis* all of which are associated with the two-spotted spider mite, *Tetranychus urticae*, on papaya. Fortunately, *A. swirskii*, introduced meanwhile by papaya growers to control *T. urticae*, does not in any way affect the biological control potential of *N. longispinosus*.

A paper on Phytoseiidae diversity and new potential for development of biological control in the Indian Ocean islands (Mauritius, Rodrigues, Comoros and La Réunion), a presentation on research progress on taxonomy of the phytoseiids in China, and yet another paper on the same family from Turkey were a clear sign of the growing interest in predatory mites, especially for biological control exploitation. The jump from a mere 49 species reported in 1958 to more than 300 to date in China demonstrates how researchers are keen to find and describe unknown phytoseiid mites. There was a solitary paper (by this author) on plant-feeding *Euseius* species from India.

It was disappointing that only a few researchers talked about the use of acaropathogens in biological control. Efforts are, however, being made to find ways to combine predatory mites and pathogens to control pests. For instance, Canadian work on the potential exploitation of *A. swirskii* and *Neoseiulus cucumeris* to deliver the entomopathogenic fungus *Beauveria bassiana* to their prey, *Frankliniella occidentalis* (the western flower thrips), drew the attention of the audience. Papers on evaluation of 17 entomopathogenic *B. bassiana* isolates against *T. urticae* in Turkey, and on the prospect of using *Metarhizium* sp. isolated from an Israeli soil to control the garlic and onion bulb mite, *Rhizoglyphus robini*, in the Czech Republic, were noteworthy.

An assortment of posters reporting on biological control made an interesting read. For example, a poster from the Republic of Korea reported that *P. persimilis* (10 prey: 1 predator) and *B. bassiana* (10^8 spores/ml) had no compatibility issues and that combined application could bring down the population of *T. urticae* to zero within six days on potted bean plants. Interesting European collaborative work indicated that the strongly aggressive intraguild behaviour of *Amblydromalus limonicus*, an alien predator being legally used across Europe against thrips in greenhouses, has contributed to its successful establishment alongside the native predator *Amblyseius andersoni*. Two posters on a new litter-inhabiting species of *Cosmolaelaps*, a laelapid mite, talked about its potential to control the edaphic phases of thrips (*F. occidentalis*) in greenhouse-grown roses and about providing alternative food to increase the biological control potential of the predator. A poster indicated the effectiveness of three phytoseiid species (*A. largoensis*, *N. chilenensis* and *N. longispinosus*) and a cheyletid species (*Hemicheyletia bakeri*) against *Brevipalpus yothersi*, a vector of citrus leprosis virus (CiLV-C) in Brazil, Colombia

and Mexico. A Turkish study indicated the potential use of a variety of endophytic fungi against *T. urticae*.

The technical tour to Bati Akdeniz Agricultural Research Institute on 5 September gave an insight on Turkish agricultural research to the delegates. It was thoughtful of the organizers to monetarily reward students for three best oral and poster presentations during the closing ceremony. The congress proceedings will be published in *Acarological Studies*, and the XVI congress is slated to be held in New Zealand.

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By: Prakya Sreerama Kumar, ICAR–
National Bureau of Agricultural Insect Resources, Bengaluru, India.
Email: psreeramakumar@yahoo.co.in